# Melt conditioned twin roll casting (MC-TRC) process for Mg alloy flat products

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Flat products (sheet/strip) of Mg alloys are desired for application in the transport sector, due to their high specific strength, low density and excellent damping capacity, to meet fuel efficiency requirements through lightweighting.

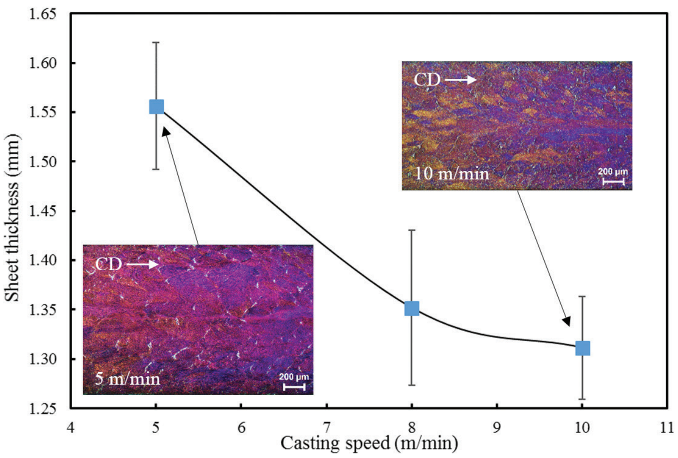


**FIGURE 1.** The relationship of strip thickness on the different casting speed. Casting direction is indicated as (CD).

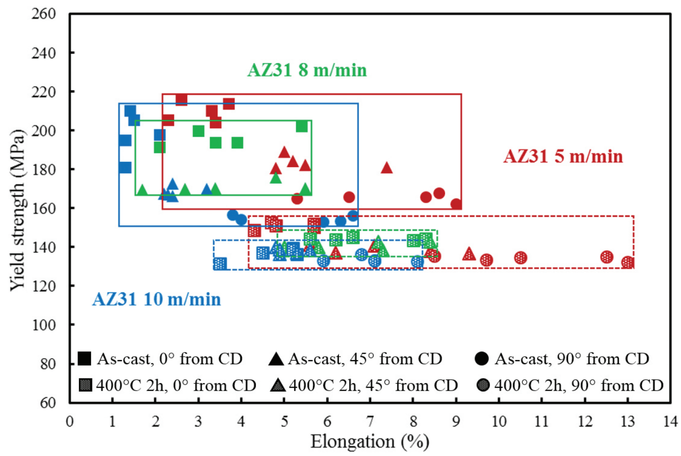


**FIGURE 2.** The tensile properties of the Mg alloy strip produced with different casting speeds.

The conventional twin roll casting (TRC) process has been used in the Mg industry in the last two decades to replace the initial slab and rolling process to significantly reduce the energy consumption and shorten the processing steps. However, TRC still faces great challenges: coarse and non-uniform microstructure; severe solute segregation (this limits alloy composition to dilute alloys with narrow freezing range); and low productivity. These problems hamper downstream processing, impact the mechanical properties of the final product and prevent its industrial application. Thus, the TRC process developed in house at BCAST aims to produce thin gauge strip with fine and uniform microstructure, no solute segregation (centre-line or inversed), good surface finish, reduced basal texture and isotropic in-plane mechanical properties, which can be used for direct component production with little rolling.

By combining two original technologies developed in BCAST, namely high shear melt conditioning (HSMC) and low force twin roll casting, the MC-TRC process is developed as an alternative approach for Mg alloy sheet/strip production by emphasising the control of solidification in the MC-TRC process compared with the conventional TRC process. By the dispersion of MgO nano-particles entrapped in magnesium oxide films, using MC, the heterogeneous nucleation is enhanced during the solidification, which provides refined equiaxed grain structures and a uniform solute distribution. With the limited load on the twin rolls, the roll surface would act as a metallic mould with high cooling rates. This helps to retain the randomised solidification texture due to limited deformation, reduce the squeeze effect of un-solidified solute rich liquid which eliminates the macro-segregation (centre-line/inversed) through the strip thickness.

The results below present the study of casting speed on the strip profile through the twin roll biting point to reduce the rolling deformation during the MC-TRC process and its impact on the mechanical properties of the as-cast strip.

Continuous reduction in strip thickness with equiaxed grain structure was observed with eliminated macro-segregation with the increased speed. This suggests that the rolling deformation is reduced with increased casting speed, indicating the randomised solidification texture retained during the MC-TRC process. With such microstructural improvement, more isotropic in-plane tensile properties are observed with increased casting speed in comparing the spread of data points obtained under different conditions. This indicates the potential formability of Mg alloy strip produced by the MC-TRC process for direct stamping without prior rolling process.

The next stages of this research will focus on the formability of Mg alloy strip produced by the MC-TRC process, by processing parameter optimisation to improve the isotropy of in-plane mechanical properties and out of plane tests (Erichsen cup tests) to explore the formability potential.